Topic A

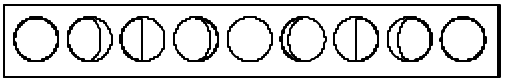
"The Visible Sky"

Part 5. Moon's Motion

(Web Version: 01-22-01)

1

Ready for the Moon?

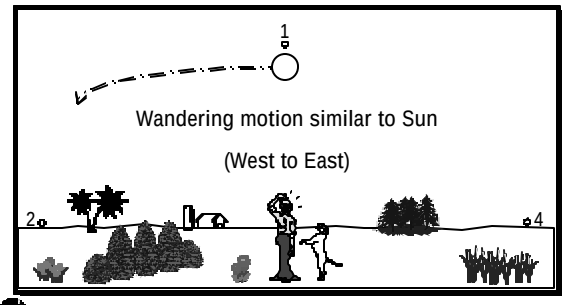


- Moon's motion similar to Sun
- A major difference — ***rate***
  (time for one trip around)

  but complication — ***phases***!

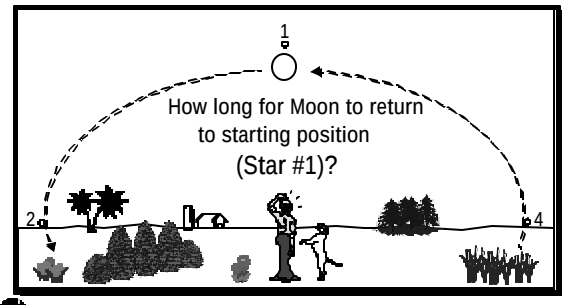
2

Moon's Motion



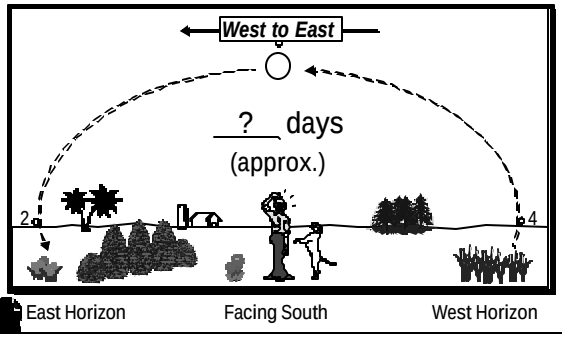
3

Question



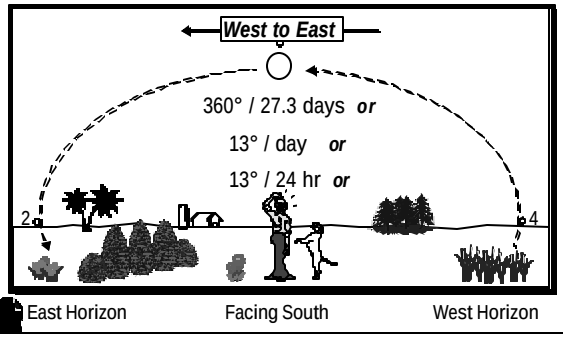
4

Answer



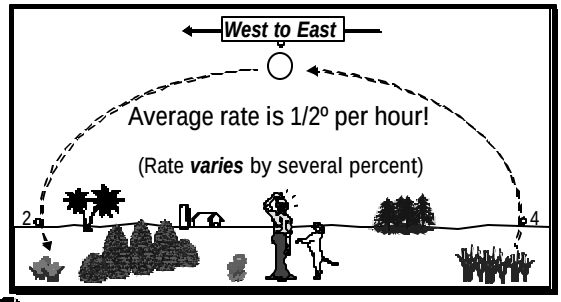
5

Moon's Rate



6

Moon's Rate

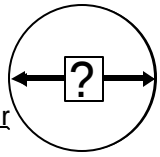


7

Remember . . .

- Moon's apparent or angular size?

  Answer: About one-half degree

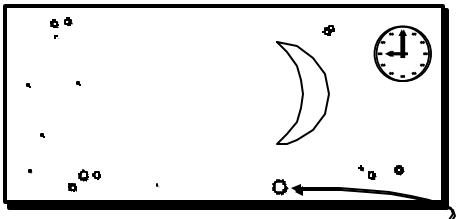


- How many Lunar diameters per hour is the Moon's motion?

  Answer: ? diameter per ***hour*** !

8

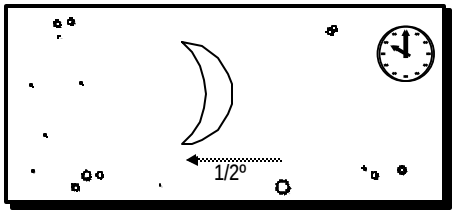
Observe The Moon



- Note position of Moon near a bright star
- Observe Moon again after an hour or so

9

Observe The Moon

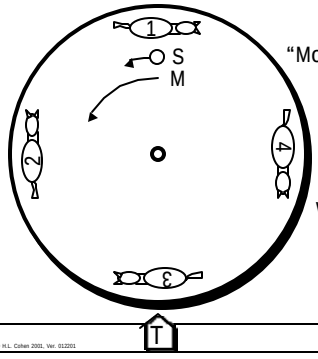


- Note position of Moon near a bright star
- Observe Moon again after an hour or so

10

"The Moon Rides Too"

The Moon ("Moony") also rides



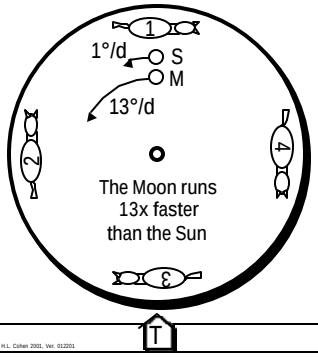
"Moony" is broke

"Moony" has no money . . . so she runs from "Sonny" who wants her ticket!

11

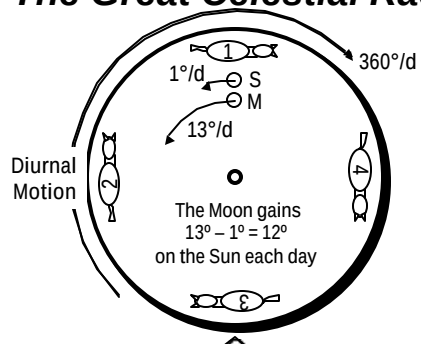
"No Problem!"

"Moony" can run faster than "Sonny"!



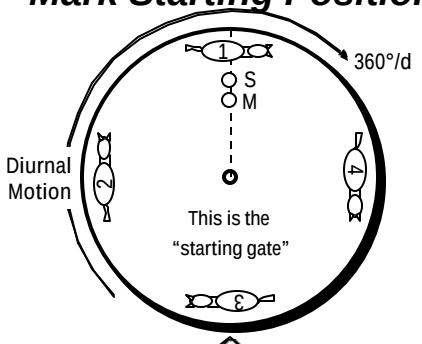
12

"The Great Celestial Race"



13

"Mark Starting Position"



14

First: Some Terminology*

- Elongation — ***Angle*** between two objects
- Aspect — ***Configuration*** of two objects ("relative ***positions"***)

*See ***Study Guide*** Table 3

15

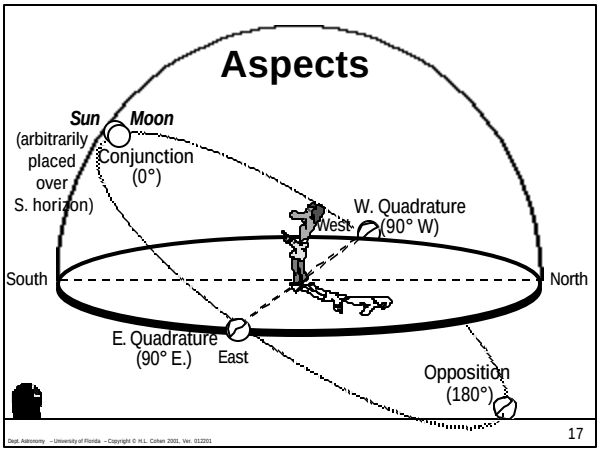
Aspects & Elongations*

Aspect	Elongation	Meaning
Conjunction	0º	"together"
Quadrature	90º (E ***or*** W)	"quarter"
Opposition	180º	"opposite"

*See ***Study Guide*** Table 3

16

Aspects



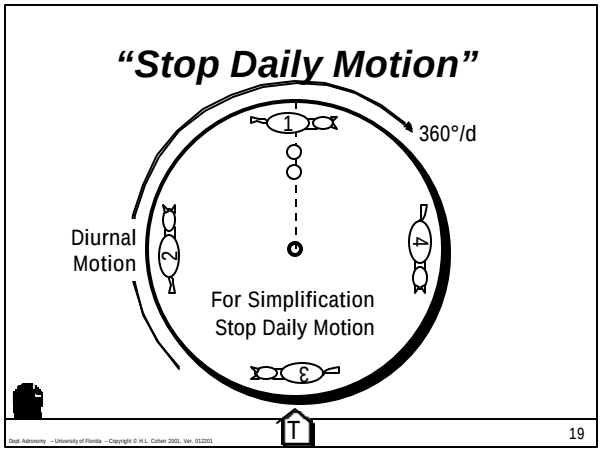
17

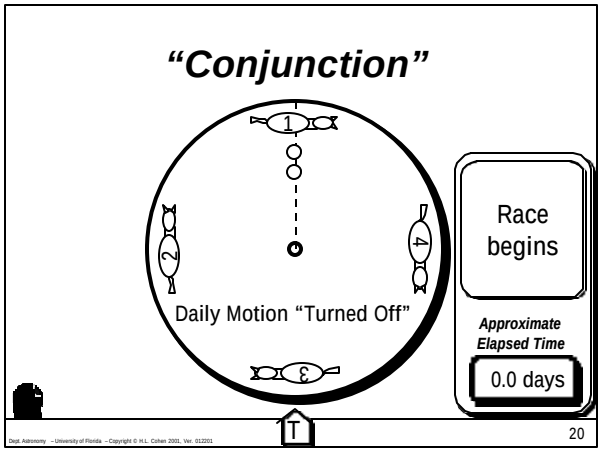
Moon's Motion Summary

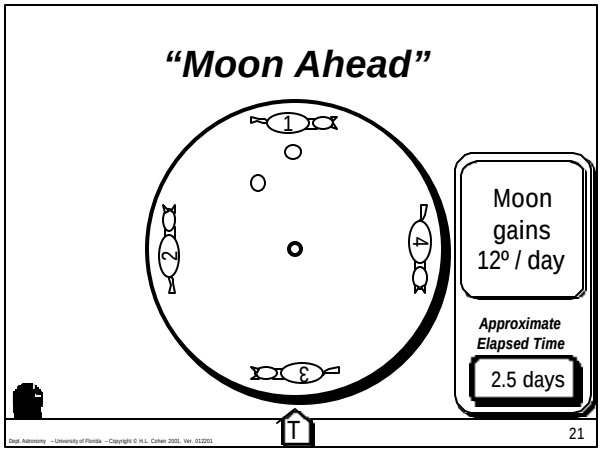
See ***Study Guide*** (Table 2)

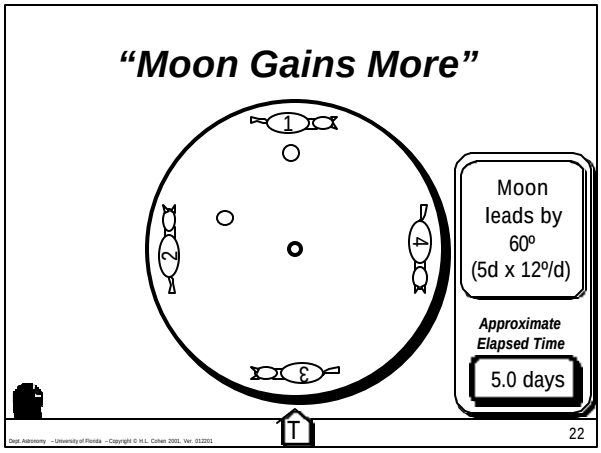
• Alternate Names	"Monthly"
• Objects	Moon
• Direction	West to East
• Average Rate	360°/27.3 days = 13°/day (1 lunar diameter/hour)
• Greatest Elongation	180° (opposition)

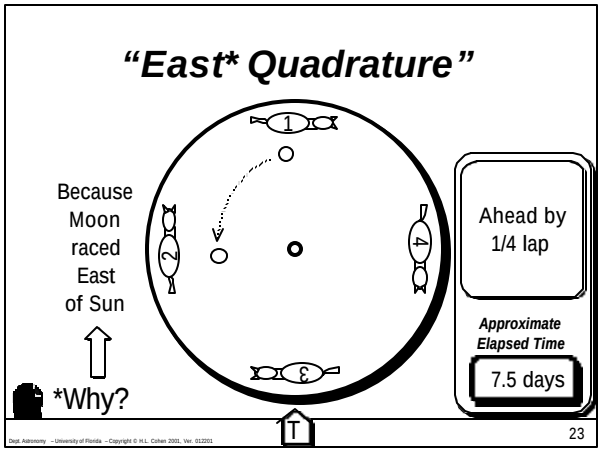
18

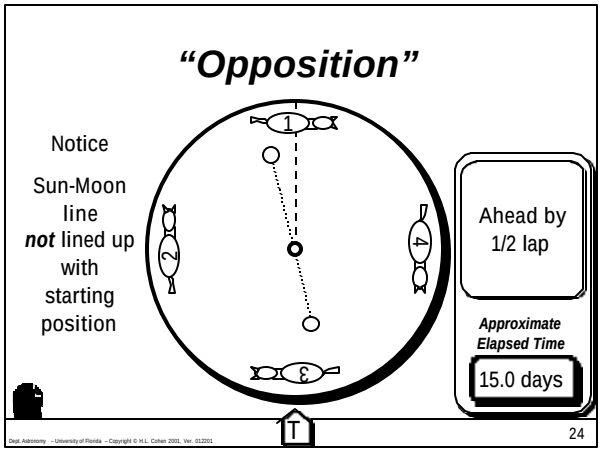


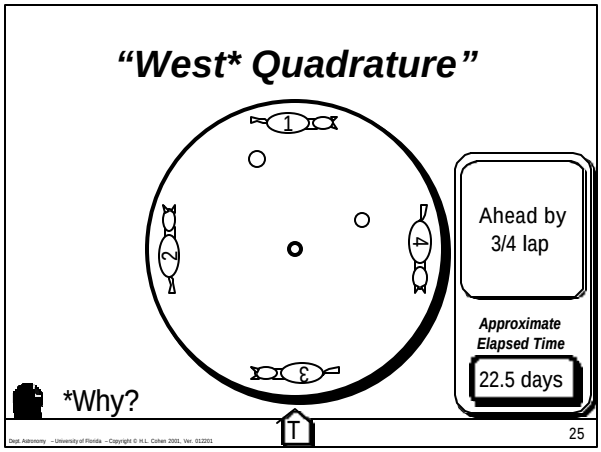


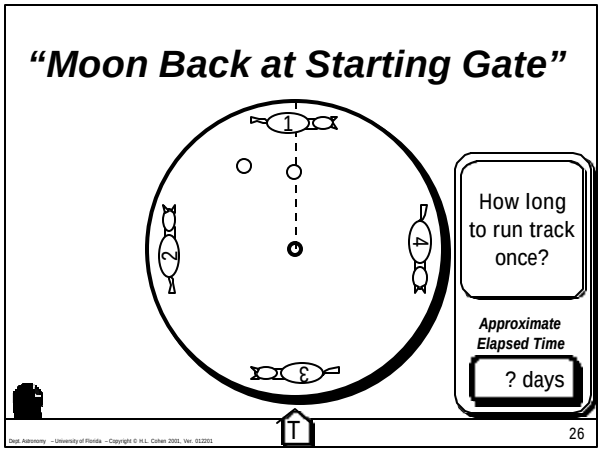


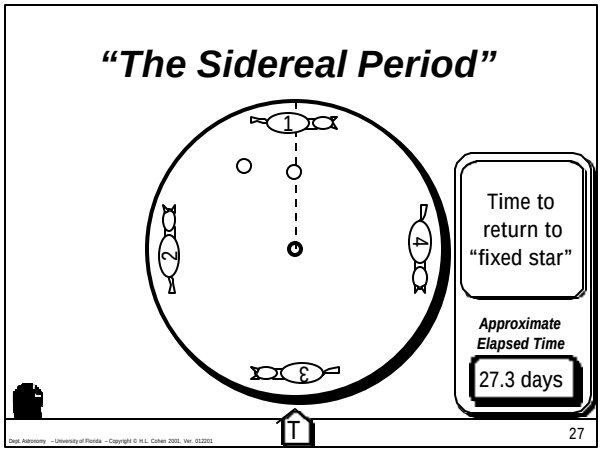


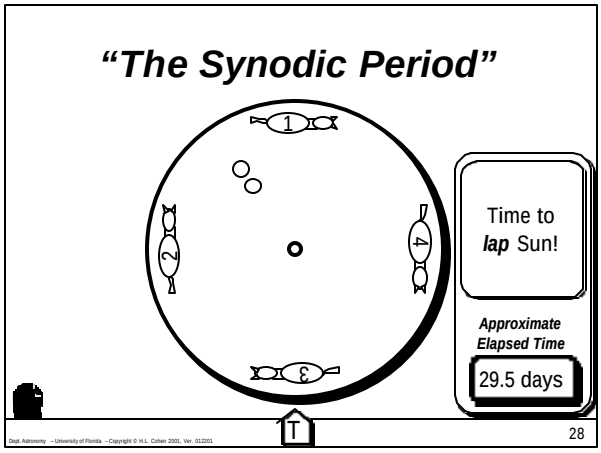












Two Lunar Periods

Sidereal 27.3 days (approx.)

Synodic 29.5 days (approx.)

29

Sidereal Period

Length 27.3 days (approx.)

Time to . . .

- Complete ***one circuit*** of race course ***or***
- Return to ***same star***

(***Sidereal*** means "star" — a "fixed point")

30

Synodic Period

Length 29.5 days (approx.)

Time to . . .

- Gain 360^{o} on Sun ***or***
- Gain ***one lap*** on Sun ***or***
- Return to ***new meeting*** (conjunction) with Sun

31

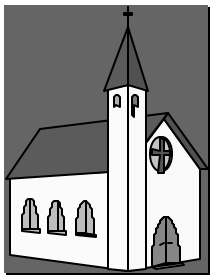
Synodic

- What does ***synodic*** mean?
  (That is — what is a ***synod*** ?)
- Notice prefix ***syn***
- Notice many other words have this prefix
  - synagogue
  - synchronous
  - syndrome
  - synergy
  - synonym
  - synopsis
  - syntax
  - synthetic
  - etc.

32

Hint

Synod
relates to the church
but spelling is
syn not sin !

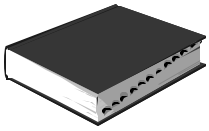


33

Find Meaning of Synod

Use a good dictionary!

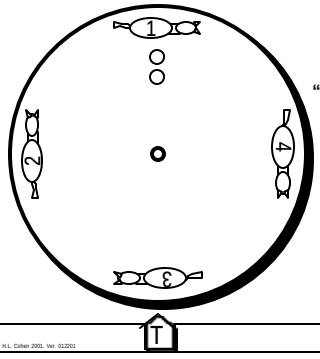
Meaning of ***synod***
shows why
lunar 29½ day cycle
called
the ***synodic period***



34

"The Race Reviewed"

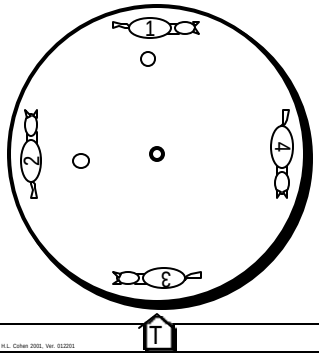
Problem?
"Moony"
has no
money.



Solution
"Moony" runs
away from
"Sonny"!

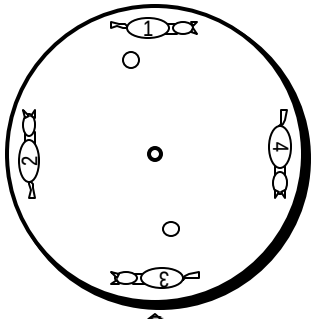
35

"East Quadrature"



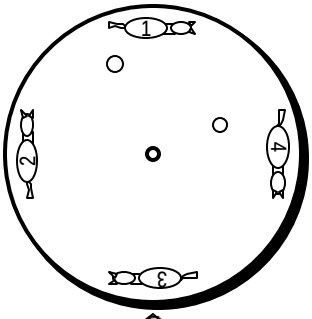
36

"Opposition"



 37

"West Quadrature"

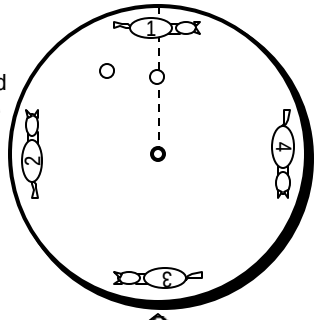


 38

"The Sidereal Period"

"Moony" runs around race course once

About 27.3 days elapse

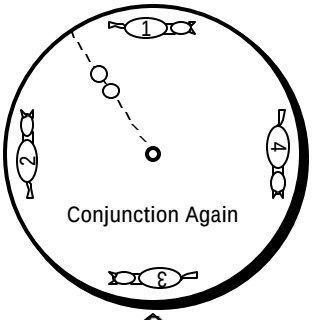


 39

"The Synodic Period"

"Moony" catches up with Sonny

About 29.5 days elapse



 40

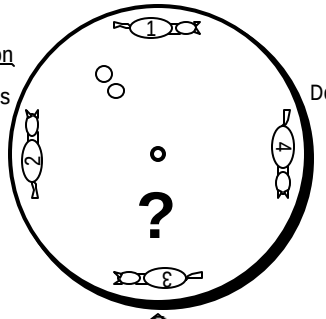
"The Synodic Period"

Complication

"Moony" has no money but has caught up with "Sonny"!

Question

Does "Moony" have to pay her money or get kicked off?



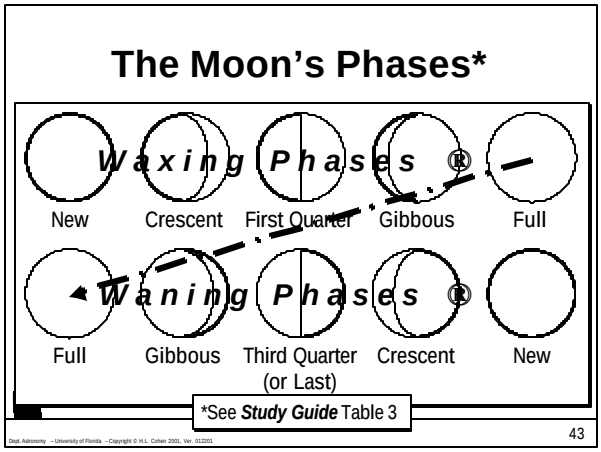
 41

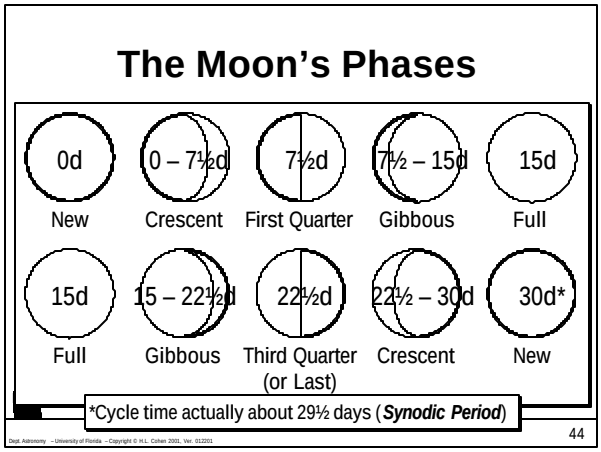
Answer from Lunar Phases*

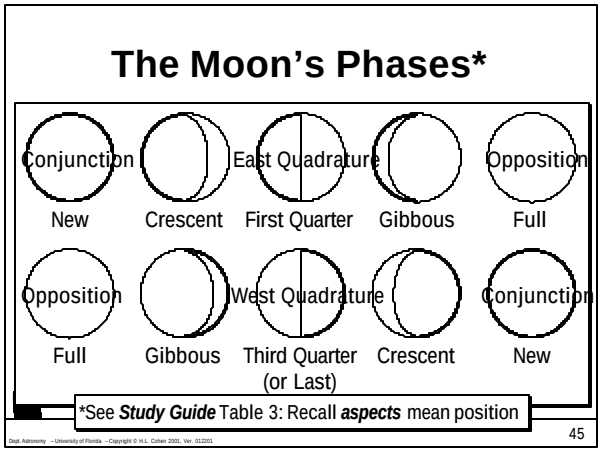
- Moon wanders and ***phases***
- Key — ***phases & aspects <u>related</u>***
- Phase ***Appearance*** of Moon's ***shape***
- Terms
  - Wax First half of cycle
  - Wane Last half of cycle

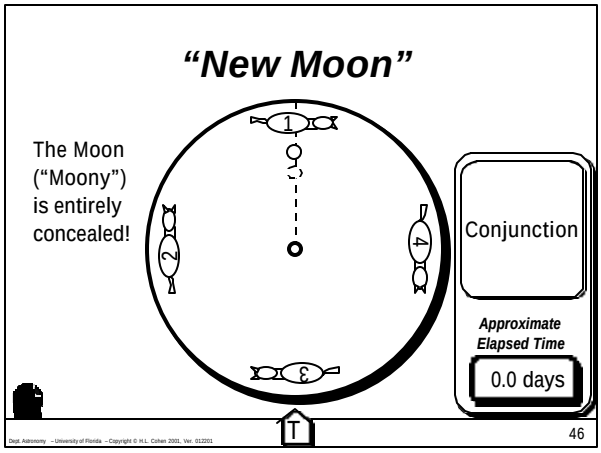
*See ***Study Guide*** Table 3

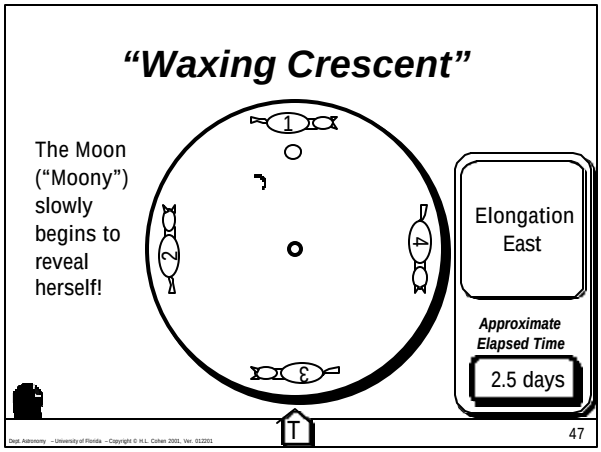
 42

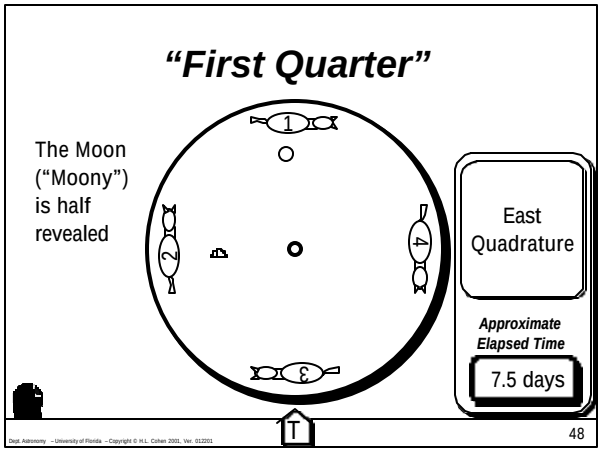


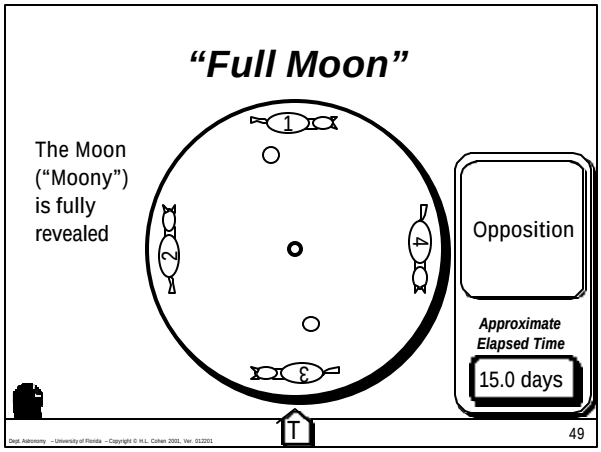


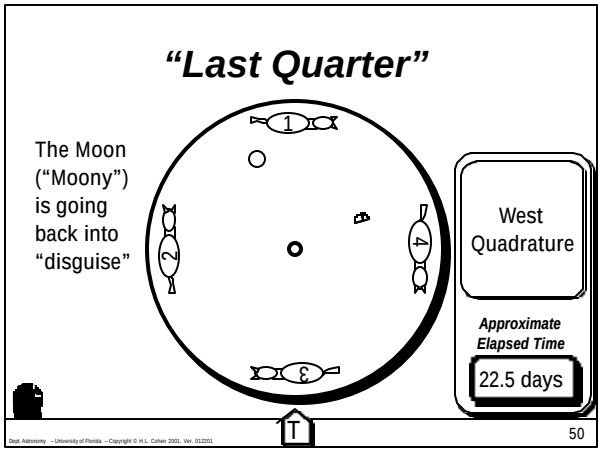


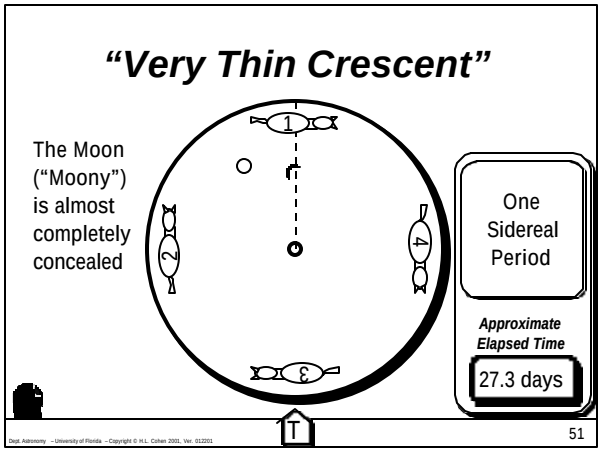


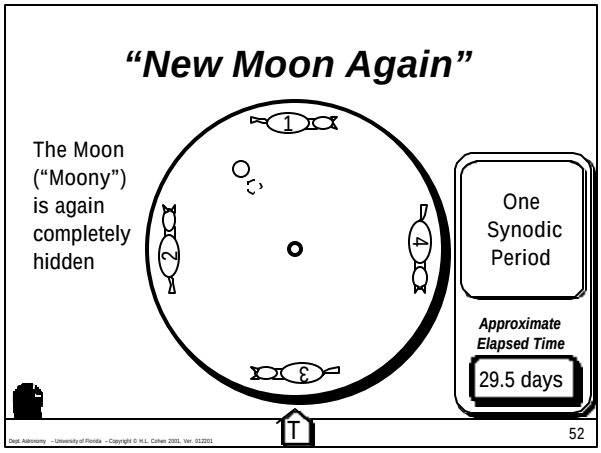












Phases Not Arbitrary

Moon phases do ***not occur by chance***

- Go hand-in-hand with ***aspects***
- Each phase occurs when Moon has a

  specific relation (position) with Sun

Dept. Astronomy – University of Florida – Copyright © H.L. Cohen 2001, Ver. 012201 53

The Synodic Period

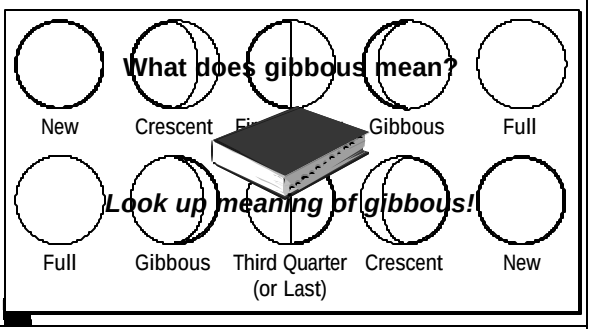
Both time to complete one

- One lap on Sun
  (return to same relative position or aspect)

  and
- One cycle of phases

Dept. Astronomy – University of Florida – Copyright © H.L. Cohen 2001, Ver. 012201 54

Notes On Moon's Phases*

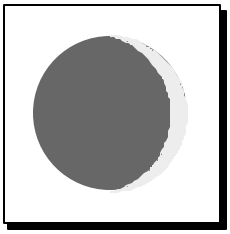


The Crescent Moon

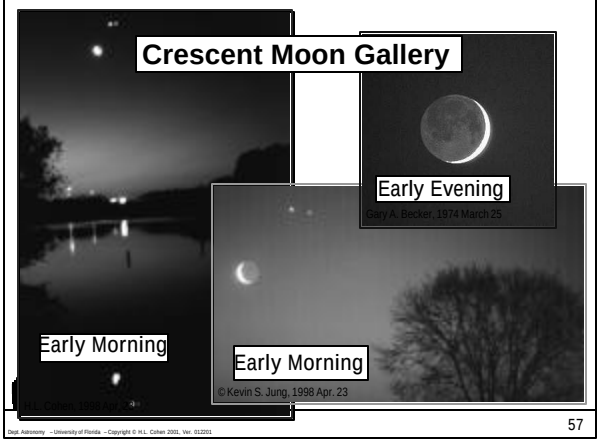
- Thin crescents show entire Moon
- Called

  "***old moon in new moon's arms***"

- Ancient Greeks thought illumination by a second, hidden heavenly "fire" !



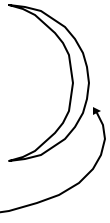
Crescent Moon Gallery



See ***Study Guide*** Table 3 (bottom)

Crescent Moon Questions

1) The "tip" or h _ _ _ or c _ _ _
2) The "line between dark & light" or t _ _ _ _ _ _ _ _ _
3) The Moon's "tips" always point in what direction?
4) The "edge" or l _ _ _
5) How many degrees long is the "arc" of the Crescent Moon?



A Young Moon

Astro Cycles

- Calendrical reckoning based on astro cycles
  Day . . . . . turn of the sky
  Month . . . . cycle of lunar phases
  Year . . . . . motion of Sun around sky
- What major calendar unit omitted?
  Answer . . . _____?

The Week

- No astro cycle = 7 days
- Origin of week unknown
- Some possible explanations

  1) One quarter lunar cycle about one week

  2) Week based on the original 7 planets!

In fact, days of week named for the 7 planets

Weekday Names

English	German	French	Planet	Teutonic
Sunday	Sonntag	Dimanche	Sun	Sun
Monday	Montag	Lundi	Moon	Moon
Tuesday	Dienstag	Mardi	Mars	Tyr
Wednesday	Mittwoch	Mercredi	Mercury	Woden
Thursday	Donnerstag	Jeudi	Jupiter	Thor
Friday	Freitag	Vendredi	Venus	Freyja
Saturday	Samstag ***or*** Sonnabend	Samedi	Saturn*	

* Only day named for a Roman god

The Month

- Based on cycle of lunar ***phases***
- How long is one lunar cycle? (one ***lunation)***

  Answer: About 29½ days (±1/4 day approx.)
- Notice similarity: "month" & "moon"

Many Words Related to Moon!

moon	meal	piecemeal
Monday	month	semester
meter	diameter	geometry
measure	dimension	immense
menses	menopause	menstruate

(Have context of marking time)

The Lunar Cycle

- One lunar cycle = 29½ days (synodic period)

  A lunar month = 29½ days "awkward"
- Solution . . .

  Devise calendar with pairs of 29 & 30 day months
- Result — average month = 29½ days

Lunar Calendar Arithmetic

- One lunar month = 29 ***or*** 30 days
- Six 29 day months = 174 days
  Six 30 day months = 180 days
  One lunar year = 354 days (12 x 29.5)
- One solar year = 365 days
- Deficit = 11 days per year!

Gregorian Calendar

Calendar based on Sun (***solar motion***)

- Romans "fiddled" with months
- Made one year = 365 days = 12 months
- "Average month" now about

  365d ÷ 12 = 30.4 days (ignoring leap years)

67

Example

• Day #1	Jan. 1, 1999	Full Moon
	Add 354 days	(12 lunar cycles)
• Day #355	Dec. 21, 1999	Full Moon
		(Jan. 1, 2000 – 11d)
so . . .		
• Day #1	Jan. 1, 2000	Waning Crescent
		(11d past Full)

68

"Example Lunar" Calendars

Calendar	Type	Length of Year
Islamic	Pure Lunar	354d (355d in leap years)
Hebrew	Lunisolar	353/354/355 & 383/384/385 (leap years have 13th month of 30d)
Chinese	Lunisolar	Same as Hebrew

69

Consequences

Calendar	Type	Holidays
Islamic	Pure Lunar	***Rotate*** through solar year
Hebrew	Lunisolar	Stay within same season
(e.g., Passover always near beginning of spring)		
Chinese	Lunisolar	Stay within same season

70

Lunar Month Examples

Can always tell lunar phase by date

Date	Phase	Calendar
Tishri 1	New Moon	Hebrew
Tishri 15	Full Moon	"
Safar 7	First Quarter	Islamic
Ramadan 10	Waxing Gibbous	"

71